U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB80-159320

Boone Creek Oil Spill

(U.S.) Environmental Protection Agency, Athens, GA

Dec 73

PB80-159320

BOONE CREEK OIL SPILL

Environmental Protection Agency
Surveillance and Analysis Division
Athens, Georgia

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB80 159320

4. Title and Subtitle

BOONE CREEK OIL SPILL

5. Report Date
December 1973

6.

7. Author(s)
Donald A. Schultz

8. Performing Organization Rept. No.

9. Performing Organization Name and Address

U. S. Environmental Protection Agency
Region 4
Surveillance and Analysis Division
Athens, Georgia 30605

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

Same

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

During the months of March through September 1972, a biological survey was conducted on the effects of a 7,000-gallon diesel fuel spill into Boone Creek, a small stream near Salem, South Carolina. Boone Creek empties into Lake Keowee, an impoundment on the Keowee River. Macroinvertebrate organisms, periphyton, and fish were collected, preserved, identified, and enumerated. Sediment samples were taken for hydrocarbon analysis. Oil was observed in the creek during the entire six-month study period. Locations downstream from the oil spill generally contained reduced numbers and types of organisms. An estimated 90% of the fish community was killed during the initial oil spill. Periphyton growths, dominated by diatoms, increased at locations downstream from the oil spill during May and June. Analysis of substrate sediment samples revealed hydrocarbons still present in Boone Creek and Lake Keowee 13 months after the spill occurred.

17. Document Analysis a. Descriptors

Oil Spills
Oil Pollution

b. Identifiers/Open-Ended Terms

Boone Creek
Salem, South Carolina

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release to Public	Unclassified	
	20. Security Class (This Page) Unclassified	22. Price

PREFACE

This report and the field studies upon which it is based were the responsibility of Mr. Donald A. Schultz, who is in charge of the biological study phases of oil and hazardous materials spills investigations in EPA Region IV. Several members of the Biological Services Branch, Surveillance and Analysis Division, Region IV, Athens, Georgia--including Drs. Ron Raschke and Louis Carrick and Messrs. David Smith, Hoke Howard, and Ronald Weldon--assisted in the field work or laboratory analysis of samples. Dennis Revell, Analytical Services Branch, S&AD, analyzed the sediment samples for hydrocarbons.

Plans for a long-term study were made subsequent to the initial trips to the spill site, with a resultant change in methodology utilized. Unfortunately, the change in methods obviates the possibility for making valid quantitative temporal comparisons. Nevertheless, because of the unexpected long-term persistence and striking effects of the Boone Creek spill, the data are being presented for the information of those working on inland waters, where there is a paucity of information on the effects of oil spills on the environment.

L. B. Tebo, Jr., Chief
Biological Services Branch
Surveillance & Analysis Division
Region IV, EPA
Athens, Georgia
December 1973

TABLE OF CONTENTS

	Page
Introduction	1
Summary	2
Description of Study Area	4
Study Methods	6
Macroinvertebrate Organisms	6
Fish	7
Periphyton	7
Sediment	7
Water Samples	8
Hydrocarbon Analysis	8
Results and Discussion	9
Macroinvertebrate Benthic Organisms	9
Fish	14
Periphyton	14
Fungi	18
Sediment	18
Chemical Analysis for Hydrocarbons	19
References	37

LIST OF TABLES

		Page
Table 1	Artificial Substrate Benthic Data from Three Stations on Boone Creek	21
Table 2	Qualitative Benthic Data from Stations on Boone Creek	23
Table 3	Invertebrate Benthic Organisms Collected by Surber Sampler at Stations on Boone Creek	29
Table 4	Total Number of Major Groups of Benthic Organisms Collected from Stations on Boone Creek	31
Table 5	Invertebrate Benthic Organisms Collected by Ponar Dredge from Lake Keowee	32
Table 6	Fish Collected from Boone Creek	33
Table 7	Average Number of Periphytic Algal Cells per Milliliter on Boone Creek	34
Table 8	Monthly Periphytic Algal Percentage Composition at Stations on Boone Creek.	35
Table 9	Percent Composition of Live/Dead Periphytic Diatoms from Boone Creek.	36

LIST OF FIGURES

		Follows Page No.
Figure 1	Oil Spill Survey Stations on Boone Creek	5
Figure 2	Total Number of Taxa and Individuals Collected with Surber and Artificial Substrate Samplers from Stations on Boone Creek, South Carolina, May-September 1972.	9
Figure 3	Total and Seasonal Mean Number of Taxa in the Major Groups of Invertebrate Benthic Organisms Collected from Stations on Boone Creek, South Carolina, March-September 1973.	13
Figure 4	Total and Combined Seasonal Mean Number of Invertebrate Benthic Organisms Collected with Surber and Artificial Substrate Samplers at Stations on Boone Creek, South Carolina, May-September 1972	13
Figure 5	Monthly Periphytic Algal Percentage Composition at Stations on Boone Creek, South Carolina, March-September 1972	14
Figure 6	Monthly Community Percentage of Periphytic Blue-green Algae, Boone Creek, South Carolina, March-September 1972	15
Figure 7	Monthly Community Percentage of Periphytic Diatoms, Boone Creek, South Carolina, March-September 1972	15
Figure 8	Monthly Community Percentage Composition of Live and Dead Pennate Diatoms, Boone Creek, March-September 1972.	15
Figure 9	Monthly Community Percentage of Coccoid and Filamentous Green Algae, Boone Creek, South Carolina, March-September 1972	17

INTRODUCTION

On March 20, 1972, an Infinger Transportation Company oil truck turned over on old South Carolina Highway 11, spilling approximately 7,000 gallons of No. 2 diesel fuel into Boone Creek, a tributary of the Keowee River.

Oil spills in inland waters make up a large portion of the yearly spillage of oil and during 1971 represented 66 percent of the total volume of oil spilled in the United States (1). Most of the individual spills that occur in inland waters are relatively small when compared with marine spills. One example of a small marine spill is that of over 650,000 liters of fuel oil from the barge "Florida" into Buzzards Bay, Massachusetts, in 1969.

Crude oil and oil fractions are poisonous to marine organisms (2). Most reports dealing with biological surveys of oil spills relate to marine spills. This study was initiated in an effort to determine the initial lethal effects and the long-term effects of No. 2 diesel fuel on the biota of a freshwater stream.

SUMMARY

On March 20, 1972, an Infinger Transportation Company truck turned over and spilled 7,000 gallons of No. 2 diesel fuel into Boone Creek, a small creek near Salem, South Carolina. Boone Creek flows into Lake Keowee about 2½ miles downstream from the spill site.

A biological survey was initiated during the month of March and continued during May, June, August, and September. A series of five stations were set up on Boone Creek and Lake Keowee to measure the oil spill effects on stream and lake organisms. Macroinvertebrate organisms, periphyton, and fish were collected, preserved, and returned to the Southeast Environmental Research Laboratory (SERL) in Athens, Georgia, where they were identified and enumerated. Sediment samples were taken for hydrocarbon analysis and microbial culturing.

Oil sheens on the water and the smell of oil were observed in Boone Creek during the entire 6-month study period.

The control station, located upstream from the spill, contained a diverse community of organisms during the entire survey.

Stations located downstream from the oil spill generally contained reduced numbers and types of organisms.

True fly larvae and dragonfly nymphs were the organisms most tolerant to the oil; and caddisfly, mayfly, and stonefly larvae were most sensitive. Few midge larvae were found in Lake Keowee after the March survey. An estimated 90 percent of the fish were killed during the initial oil spill. A partial recovery of fish and insect larvae was noted in the September 1972 survey.

Periphyton growths increased at the stations downstream from the oil spill during May and June. This periphytic growth diminished during August. Pennate diatoms dominated the periphyton community in Boone Creek during most of the season.

The growth of filamentous blue-green algae decreased during the season at the lower downstream stations.

Microbial culturing of creek sediment indicated the presence of a high population of fungi capable of living on diesel fuel.

Analysis of sediment samples from stream banks, stream bottom, and lake bottom revealed hydrocarbons still present in Boone Creek and Lake Keowee substrates 13 months after the spill occurred.

DESCRIPTION OF STUDY AREA

The headwaters of Boone Creek form from a number of unnamed creeks in the highlands of Oconee County, South Carolina, north of the town of Salem (Figure 1). The creek flows eastward for a distance of about 2½ miles before joining Lake Keowee, an impoundment of the Keowee River. The gradient of Boone Creek is about 145 feet per mile. The elevation ranges from 1,150 feet above sea level at its source to 800 feet at Lake Keowee. The substrate of the creek is mainly sand and gravel with areas of larger rock, exposed bedrock, and silt.

The Boone Creek watershed is covered with hardwoods and pines along with extensive undergrowth that overhangs the stream in many areas. Mosses cover the clay banks, many of the larger submerged rocks, and sections of exposed bedrock.

LOCATION OF STATIONS

Station 1A is located on Boone Creek about 500 feet upstream from old South Carolina Highway 11. This station is upstream from the oil spill and is designated as the control station.

Station 1 is located on Boone Creek about 700 feet downstream from old South Carolina Highway 11.

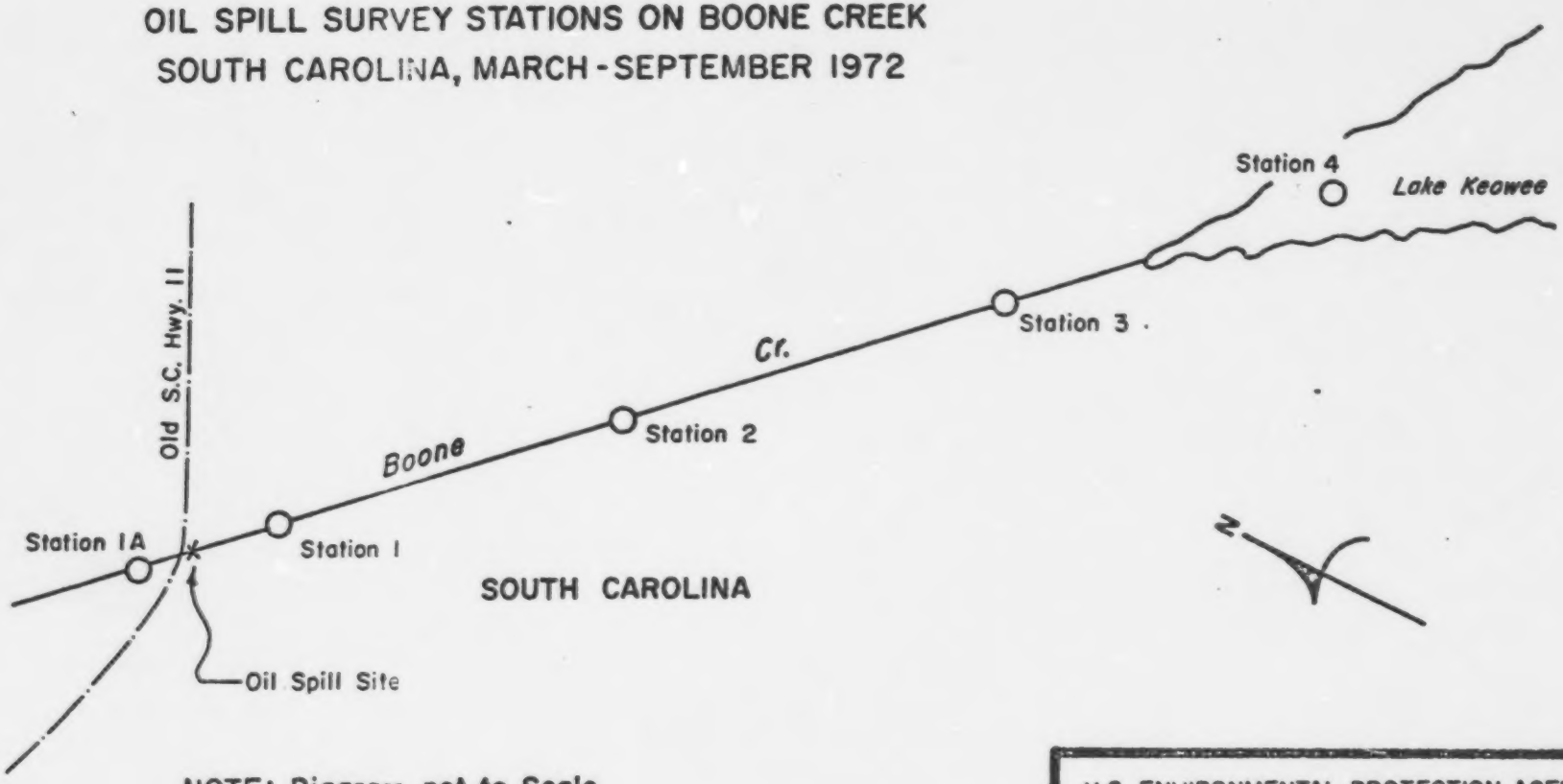
Station 2 is located on Boone Creek about ½ mile downstream from old South Carolina Highway 11.

Station 3 is located on Boone Creek about 300 feet upstream from Lake Keowee.

Station 4 is located about 1,000 feet into the Boone Creek arm of Lake Keowee.

FIGURE 1

OIL SPILL SURVEY STATIONS ON BOONE CREEK SOUTH CAROLINA, MARCH - SEPTEMBER 1972



NOTE: Diagram not to Scale

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV

OIL SPILL SURVEY

SURVEILLANCE AND ANALYSIS DIVISION
ATHENS GEORGIA

5a

STUDY METHODS

Biological surveys of Boone Creek were conducted during March, May, June, August, and September, 1972. The original survey trip in March was conducted to investigate the oil spill. After this initial trip, several follow-up trips were planned to survey the recovery of the biotic community. Sampling methods were modified during the various periods to include quantitative sampling gear.

Macroinvertebrate Organisms

During the March survey, sampling was limited to qualitative means with hand and dip-net collections from rocks, logs, and other substrates. Single, wire, cylindrical baskets were filled with granite stones and placed at Stations 1A, 1, and 3 during March. These artificial substrate samplers were retrieved each following sampling period, cleaned of benthic organisms, and reestablished at the same spot. Starting in June, and thereafter, a Surber bottom sampler was also used to collect macroinvertebrate organisms. One sample was taken at each station per sampling period. Data from the artificial substrate and Surber samplers were summed to provide a gross quantitative comparison of numbers of individuals collected.

A Ponar dredge was used to collect triplicate samples of benthic organisms in Lake Keowee during all sampling periods.

Benthic samples for animal analyses were concentrated in a U.S. Standard 30 mesh sieve and preserved with 70 percent ethanol. Sorting, identification, and enumeration of the organisms were conducted at SERL. Benthic samples for hydrocarbon analysis were iced down and transported to SERL for analysis.

Fish

Dead fish were picked up along Boone Creek at the time of the oil spill in March. A Coffelt electronic fish shocker and dip nets were used to collect live fish. Fish were sampled at Stations 1A, 1, and 3 on March 25 and September 13, 1972. The March survey was conducted by Don Archer, South Carolina Wildlife Resources Department biologist. The September survey was conducted by Don Archer and SERL biologists. Fish were identified, weighed, measured, and counted in the field.

Periphyton

Periphyton samples were collected by scraping algal growth from submerged rocks. Parts of samples collected at Station 2 during June and August were iced down and returned to SERL for hydrocarbon analysis. All other samples were preserved with Transeau's solution (3) and returned to SERL. Differential counts were made of the algal samples using a Sedgwick-Rafter microscopic cell. Percentage composition of the algal community was used to express community structure.

Sediment

Samples of clay and trapped sediment were collected from the lower stream banks of Boone Creek at all stations during March, June, August, and September 1972 and March 1973. Lake bottom samples were collected from the station on Lake Keowee during the same periods. The samples were iced down and returned to SERL for hydrocarbon analysis. Part of the August sediment samples were sent to Dr. Donald Ahearn, Georgia State University, Atlanta, Georgia. Dr. Ahearn attempted to culture hydrocarbonoclastic flora from the sediment samples.

Water Samples

Water samples for hydrocarbon analysis were collected with a Kemmerer sampler from the surface and near the bottom at the Lake Keowee station. Samples were iced down and returned to SERL for analysis.

Hydrocarbon Analysis

For sediment and periphyton, hydrocarbons were extracted according to the 1971 edition of STANDARD METHODS FOR EXAMINATION OF WATER AND WASTE-WATER ~~(Extraction Methods for Sludge Samples, 209 C., page 413)~~. This methodology was used with the following exceptions: anhydrous sodium sulfate was used instead of magnesium sulfate; the organic solvent used was petroleum ether; samples were concentrated to 1 milliliter.

Fish and invertebrate organism samples were chopped up and blended with dry ice; then the dry ice was allowed to sublimate overnight. Twenty grams of samples were combined with 80 grams anhydrous sodium sulfate, extracted with column extraction using petroleum ether, and cleaned up with florisil. Samples were concentrated to 1 milliliter.

For water samples, 1 liter was extracted with three 50-milliliter portions of petroleum ether and concentrated to a 1-milliliter volume.

Hydrocarbon analysis was conducted using gas chromatography with flame ionization and flame photometric detectors for identifying hydrocarbons in the sediment, periphyton, fish, and macroinvertebrate samples.

RESULTS AND DISCUSSION

Macroinvertebrate Benthic Organisms

The three methods of benthic sampling used in this study--dip nets and hand-picking, artificial substrate sampler, and Surber sampler--all sampled similar types and numbers of organisms during the 6 months that the biological sampling was carried out. However, there were periods when a particular sampler was more successful for collecting specific benthic groups than the other samplers. The combined samples taken by these various samplers gave a better conception of the stream benthic community than any one taken separately.

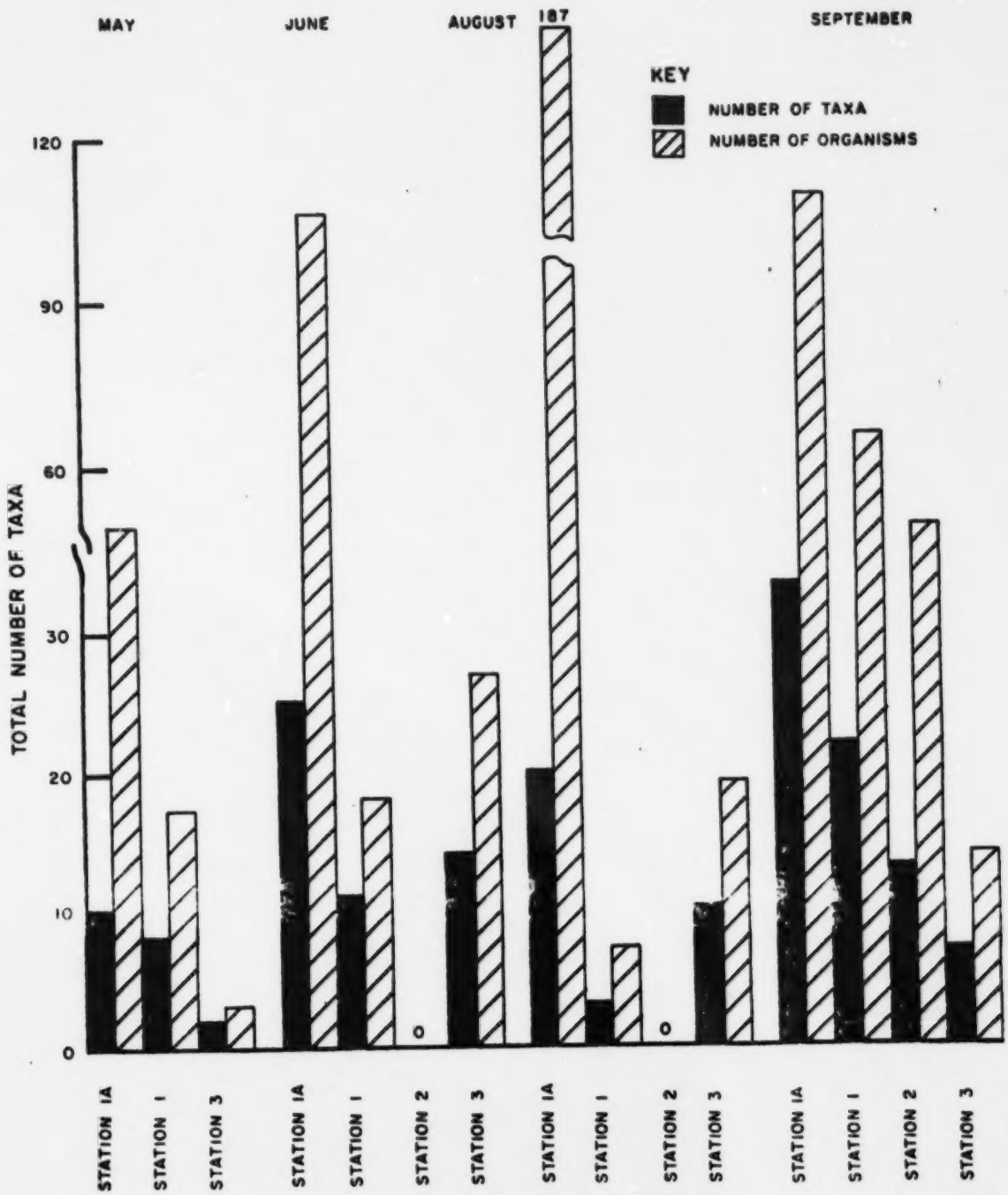
Since the Surber sampler and the artificial substrate samplers provided the only comparative measure of quantity, the discussion of numerical abundance will be limited to these samples.

The control station (1A), located upstream from the oil spill, contained a diverse group of organisms during the entire period of study. The mean number of taxa at Station 1A was 28 (Figure 3), and the mean number of individuals collected was 59 (Figure 4). Seasonal high for species richness occurred in June with low in August (Figure 3). The largest number of organisms was captured in August and the lowest number in May (Figure 2).

All stations located downstream from the oil spill generally contained reduced numbers and types of organisms. The only exception was the first station downstream from the oil spill (Station 1) during the March sampling period. Forty-nine types of benthic organisms were collected at Station 1 during this period (Figure 3). The highest number of individuals were collected in September and the lowest number in August (Figure 2). The mean number of taxa for Station 1 was 22 (Figure 3), and the mean number

FIGURE 2

TOTAL NUMBER OF TAXA AND INDIVIDUALS COLLECTED WITH SURBER AND ARTIFICIAL SUBSTRATE SAMPLERS FROM STATIONS ON BOONE CREEK, SOUTH CAROLINA, MAY - SEPTEMBER, 1972



of individuals was 17 (Figure 4). The month of August had the lowest number of both taxa (Figure 3) and individuals (Figure 2) collected.

The mean number of taxa (Figure 3) and mean number of individuals (Figure 4) at the second downstream station (Station 2) were 9 and 16, respectively. The high species richness for the season occurred in September, with the same low in May and June (Figure 3). Numerical abundance reached a peak in September, with the low tied in June and August (Figure 2).

The most downstream station (Station 3) had a seasonal taxa mean of 14 (Figure 3) and a mean of individuals of 10 (Figure 4). June was the month with the largest number of individuals captures and May the least (Figure 2). June was also the month with the most diverse group of taxa (Figure 3) and May the least (Figure 3).

The macroinvertebrate organisms collected at the sampling stations can be divided into several groups according to their response to the diesel fuel. One group of macroinvertebrates included those which were not collected from the downstream station after the March period and probably were killed by the diesel oil. They did not become re-established during the 6-month period of study.

Midge larvae (Chironomidae)
- Polypedilum illinoense
- P. parascalaenum
- Psectrotanypus dena
- Orthocladius dubitatus
- O. thienemanni
- Phaenopsectra obediens
- Cricotopus sp. 2 Roback
- C. junus
- C. fugax
- Harnischia anis
- Microtendipes pedellus
- Diamesa fulva
- Parachironomus sp.
- Nanocladius sp. 1
- Metriocnemus sp.

Cranefly larvae (Tipulidae)
Dicronota sp.
Eriocera sp.
Tabanidae
Chrysops sp.

Biting midge larvae (Ceratopogonidae)
Dasyhelea sp.
Palpomyia sp.

Mothfly larvae (Psychodidae)
Psychoda sp.

Stonefly nymphs (Plecoptera)
Pteronarcys proteus
Isoperla clymene

Mayfly nymphs (Ephemeroptera)
Ephemera varia
Leptophlebia sp.

Damesfly nymph (Zygoptera)
Argia sp.

Dragonfly nymph (Anisoptera)
Lanthus albistylus

Caddisfly larvae (Trichoptera)
Nyctiophylax sp.
Sericostoma sp.
Glossosoma sp.
Neophylax nactus
N. sp.
Anisocentropus pyralodies
Lepidostoma sp.
Psilotreta sp.
Lype diversa
Rhyacophila sp.

True bug nymphs (Hemiptera)
Gerris sp.
Rhagovelia sp.

Dobson fly larvae (Megaloptera)
Nigronia serricornis
N. fasicatus
Chauliodes sp.

Beetle larvae (Coleoptera)
Psephenus sp.
Rhantus sp.
Dineutus sp.
Promoresia tardellus
Optioservus immunis
Helichus sp.

Another group of organisms was considerably tolerant of the oil. These organisms were collected repeatedly at the stations downstream from the spill and are listed below:

Midge larvae (Chironomidae)
- Nanocladius alternantherae
- Diamesa longimanus
- Conchapelopia sp.
- Trichocladius sp. 1
- Polypedilum scalaenum
- P. halterale
- Brillia sp.
- Cricotopus slossonae
- C. bicinctus

Stonefly nymphs (Plecoptera)
- Acroneuria arida
- A. abnormis

Mayfly nymphs (Ephemeroptera)
- Stenonema sp.
- Hexagenia limbata
- Ephemerella dorothea
- Baetis sp.
- Centroptilum sp.

Beetle larvae (Coleoptera)
- Stenelmis sp.

Caddisfly larvae (Trichoptera)
- Rhyacophila fuscula
- Pycnopsyche luculenta

Damsefly nymph (Zygoptera)
- Calopteryx sp.

Crayfish (Decapoda)
- Cambarus sp.

A number of taxa had comparatively large populations at the control station, with lesser numbers at the downstream stations. The first downstream station generally contained more of these organisms than the lower stations (Figure 3). Drift of benthic organisms from upstream is the most common means of repopulation of barren stream areas (5). This constant drift of organisms probably contributed to the downstream population. The organisms mentioned above include the following:

Caddisfly larvae (Trichoptera)
Chematopsyche sp.
Hydropsyche sp.

Stonefly nymph (Plecoptera)
Peltoperla sp.
Leuctra sp.

A partial recovery of Boone Creek in September (6 months after the spill) was indicated by an increase in numbers of present taxa (Figure 3). The presence of previously absent mayfly larvae was noted at this time. A marine spill of diesel fuel at West Falmouth, Massachusetts, depopulated an area for up to 9 months (6).

True fly larvae and dragonfly nymphs were the most tolerant organisms to the diesel fuel (Table 4). Caddisfly larvae, mayfly larvae, and stonefly larvae were the most sensitive (Table 4).

Ponar dredge bottom samples were collected from Lake Keowee about 1,000 feet from the mouth of Boone Creek. A diverse group of true fly larvae were collected during the March survey. The community of lake organisms was greatly reduced in number and diversity during the sampling period from May to September (Table 5). Except for the June sampling period, the only organism that was collected during this time was the phantom midge larvae, *Chaoborus punctipennis*. This organism remains in the water column of the lake; it does not live in sediments, as do many other true fly larvae. The sediment at this station contained a strong odor of diesel fuel during the entire March to September period, and a sheen of oil was noticeable in Ponar dredge samples. Blumer (10) reported No. 2 diesel fuel remained in sediments of Buzzards Bay, Massachusetts, 24 months after a spill occurred.

FIGURE 3

TOTAL AND SEASONAL MEAN NUMBER OF TAXA IN THE MAJOR GROUPS OF INVERTEBRATE BENTHIC ORGANISMS COLLECTED FROM STATIONS ON BOONE CREEK, SOUTH CAROLINA, MARCH - SEPTEMBER 1973

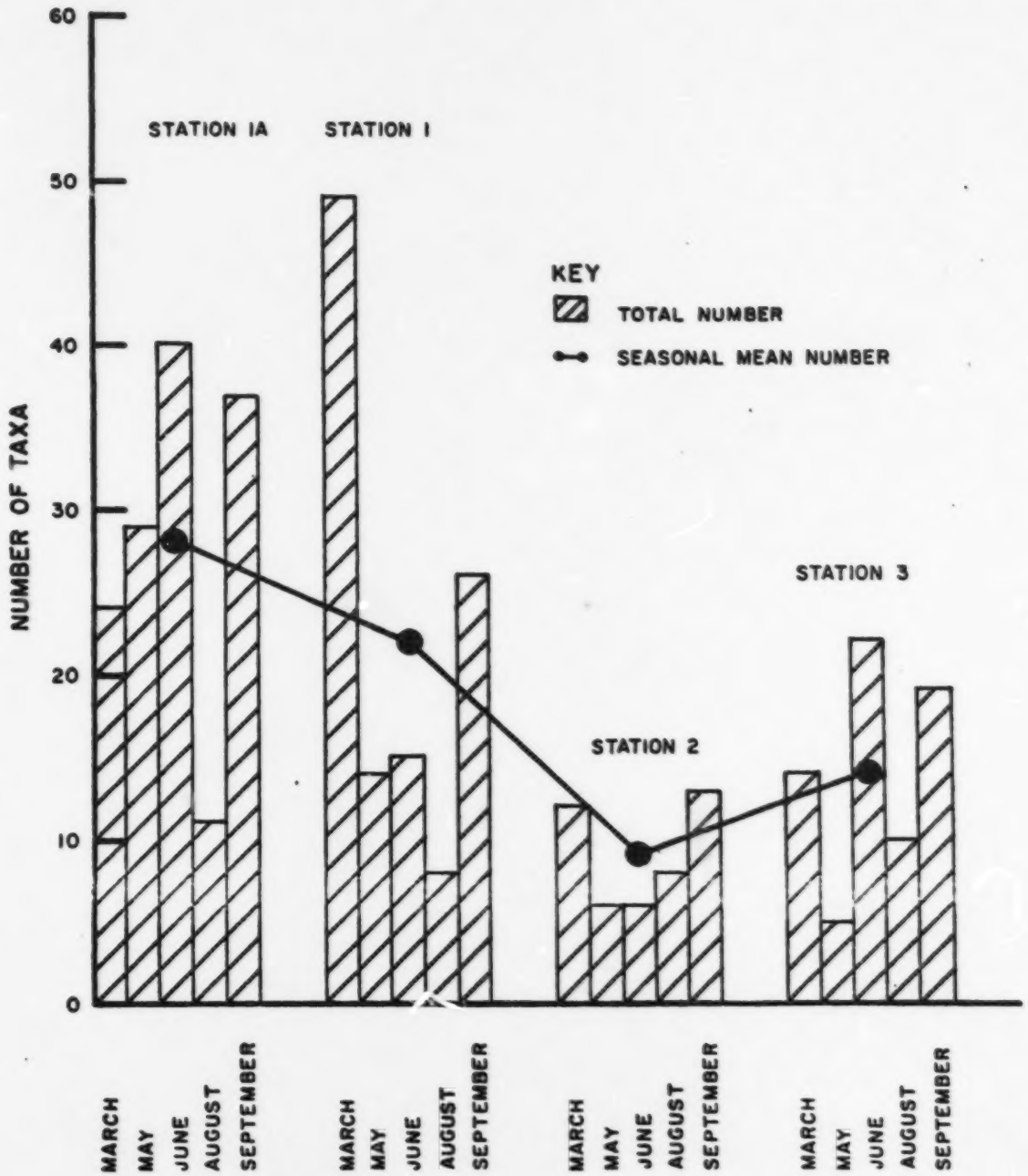
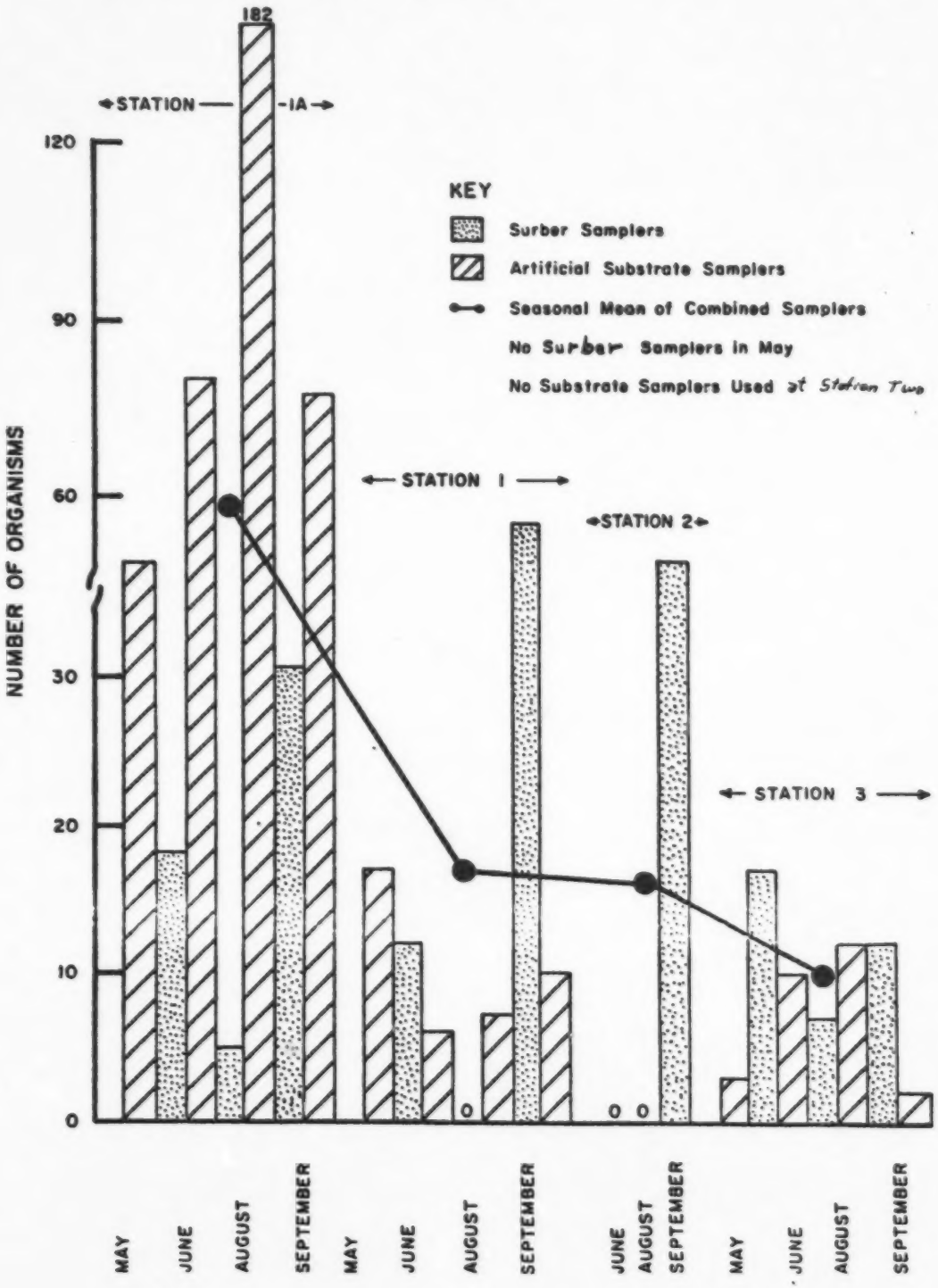


FIGURE 4

TOTAL AND COMBINED SEASONAL MEAN NUMBER OF INVERTEBRATE BENTHIC ORGANISMS COLLECTED WITH SURBER AND ARTIFICIAL SUBSTRATE SAMPLERS AT STATIONS ON BOONE CREEK, SOUTH CAROLINA, MAY - SEPTEMBER, 1972



Fish

Surveys of the fish population in Boone Creek were conducted during the months of March and September. Dead fish were picked up on March 24 along Boone Creek near the three stations downstream from the oil spill. On March 25, an electric shocker was used to sample the fish population at the same sites and at the control station. Five-hundred-foot sections of stream were sampled at each location. Donald Archer, South Carolina fishery biologist, estimated that 90 percent of the standing crop of fish in the stream were killed as a result of the oil spill. The September sampling of fish in Boone Creek indicated an increase in all the types of fish collected as compared with the March survey (Table 6).

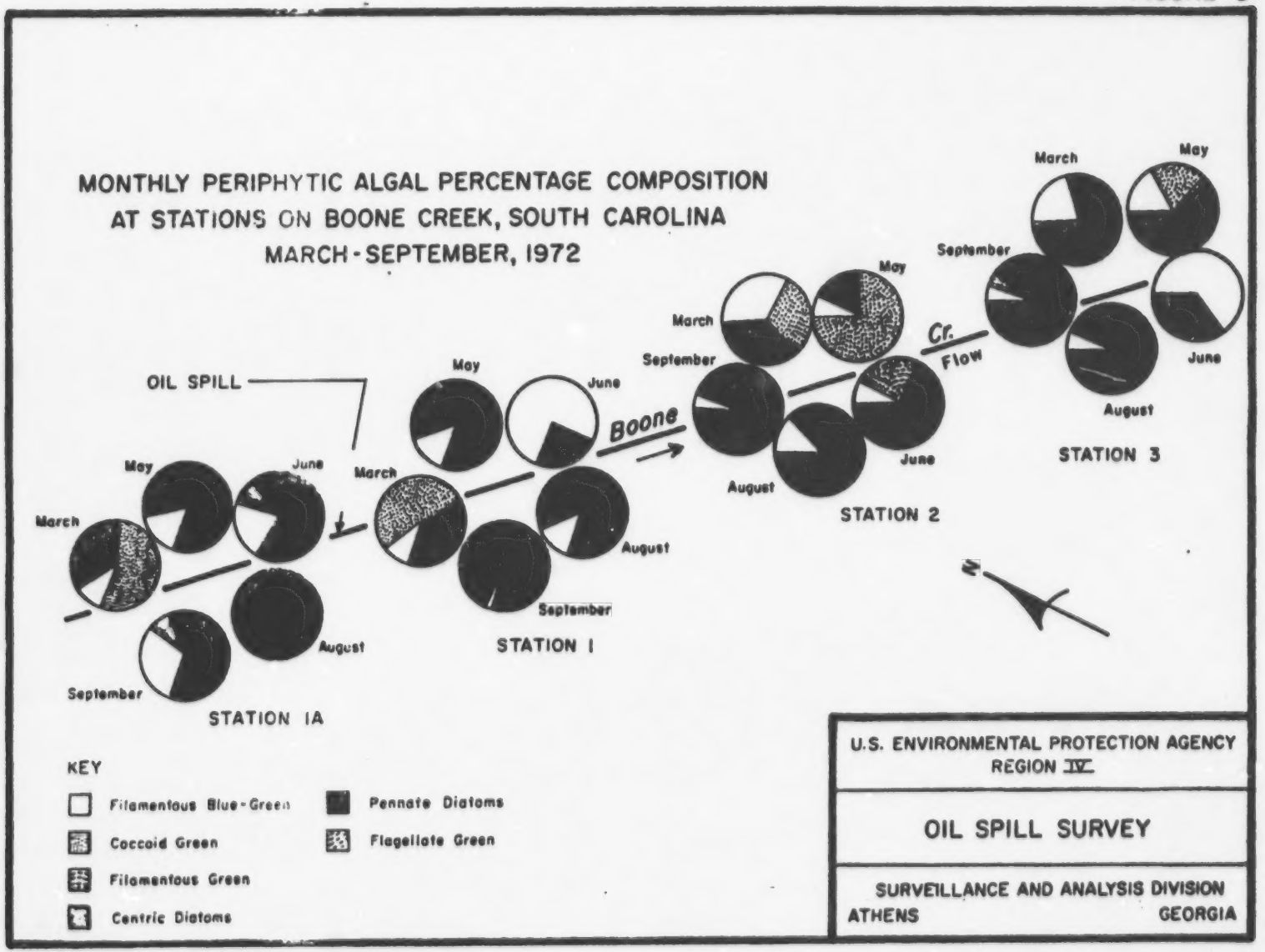
Periphyton

Increased algal periphyton growths resulting from oil spills have been observed in various ecosystems. A large algal growth was observed on a coral reef off the Pacific island of West Fayu during the weeks following a tanker spill of fuel oil (9). Kauss, et al. (11) noted an increase of cells in a culture of Chlorella sp. when exposed to crude oil and outboard motor oil.

During May and June, increased periphyton growths were observed at stations downstream from the Boone Creek spill site. A thin periphyton layer was present on the substrates at the upstream control station at this time. The heavy periphyton growth diminished in August. The September periphytic community was dominated by pennate diatoms at all stations.

The March periphytic algal community was dominated by coccoid greens of the genera Closterium and Cosmarium at the control station (Figure 5). A reduction of the same genera of coccoid greens in the March periphytic community was noted in samples collected from stations downstream from the

FIGURE 5


MONTHLY PERIPHYTIC ALGAL PERCENTAGE COMPOSITION
AT STATIONS ON BOONE CREEK, SOUTH CAROLINA
MARCH - SEPTEMBER, 1972
OIL SPILL
Boone
Cr. Flow
March
May
June
August
September
STATION IA
STATION 1
STATION 2
STATION 3
KEY
Filamentous Blue-Green
Coccoid Green
Filamentous Green
Centric Diatoms
Pennate Diatoms
Flagellate Green
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV
OIL SPILL SURVEY
SURVEILLANCE AND ANALYSIS DIVISION
ATHENS
GEORGIA

14.a

oil spill. Collections at the most downstream station (Station 3) contained only 3 percent coccoid green algae during March.

During May, coccoid green algae were absent from periphytic collections at the control station (Station 1A) and the first downstream station (Station 1). At the middle (Station 2) and lower downstream station (Station 3), Closterium increased considerably over the March population. Thic increase may be partly due to a tolerance of oil. McCauley (8) found that Closterium was able to grow in water polluted with diesel fuel.

Coccoid green algae did not make up a major percentage of the community at any station during June, August, or September.

The diatom community at Boone Creek was dominated by pennate forms over centric forms at all stations and during all months sampled (Figure 7). Weber and Raschke (12) found that pennate diatoms dominated the periphytic community on artificial samples suspended in the Ohio River. They found that centric diatoms dominated the plankton community in grab samples taken near the periphytic samplers.

Pennate diatoms appeared to go through a normal seasonal cycle at the control station (Station 1A)(Figure 5). Pennate diatoms increased from a March low, dominated during May and June, represented the only periphytic growth during August, and then decreased in September.

Diatoms at the stations downstream from the oil spill somewhat resembled the control station cycle during the March-through-September period (Figure 5). In June, pennate diatoms at the first downstream station (Station 1) were less abundant than at the control station (Figure 5). The middle downstream station (Station 2) diatom abundance decreased in May but increased in June to approximate numbers at the control station.

FIGURE 6

MONTHLY COMMUNITY PERCENTAGE OF PERIPHYTIC BLUE-GREEN ALGAE, BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER, 1972

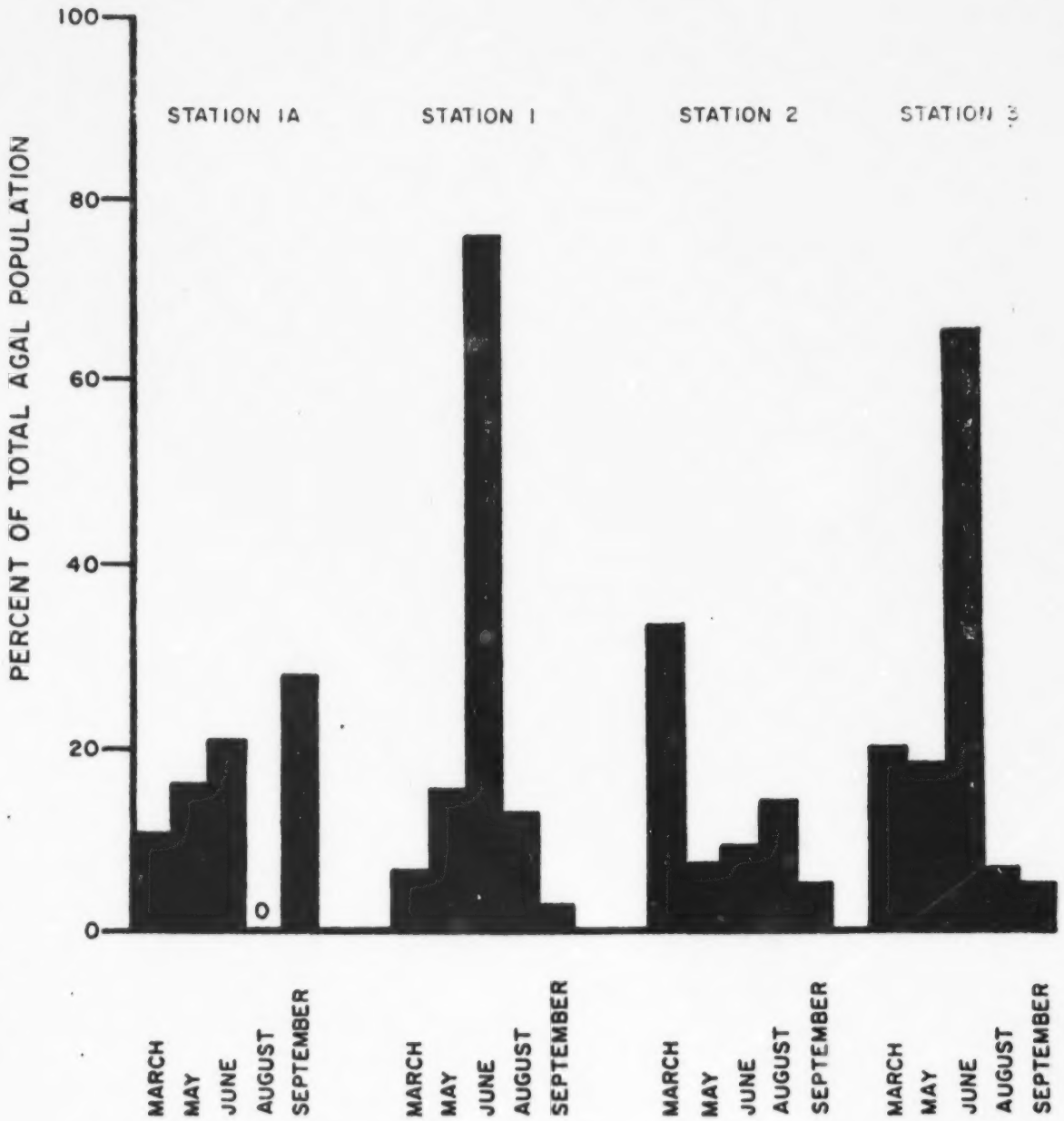
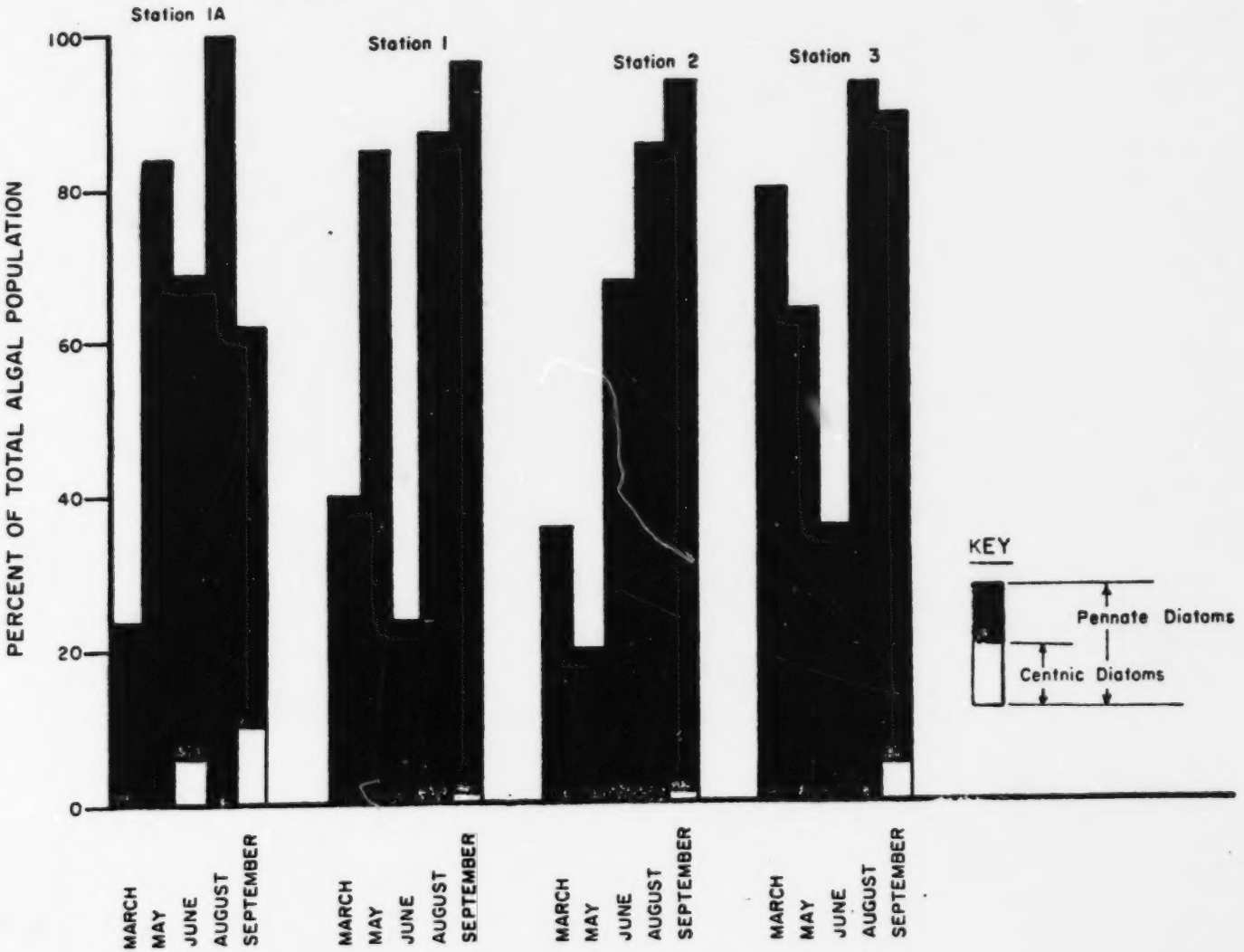


FIGURE 7

MONTHLY COMMUNITY PERCENTAGE OF PERIPHYTIC DIATOMS, BOONE CREEK, SOUTH CAROLINA, MARCH - SEPTEMBER



Pennate diatoms at the middle station continued increasing to a high in September, at which time the control station diatom abundance was decreasing.

The number of pennate diatoms at the lower downstream station (Station 3) was the highest for stations during the month of March (Figure 5). The March diatom community decreased during May and June but increased again to a high number in August and September.

Centric diatoms increased in number at the control station (Station 1A) during September, while the pennate diatoms were decreasing (Figure 5). The periphytic communities at the downstream stations contained only a small percentage of centric diatoms during September.

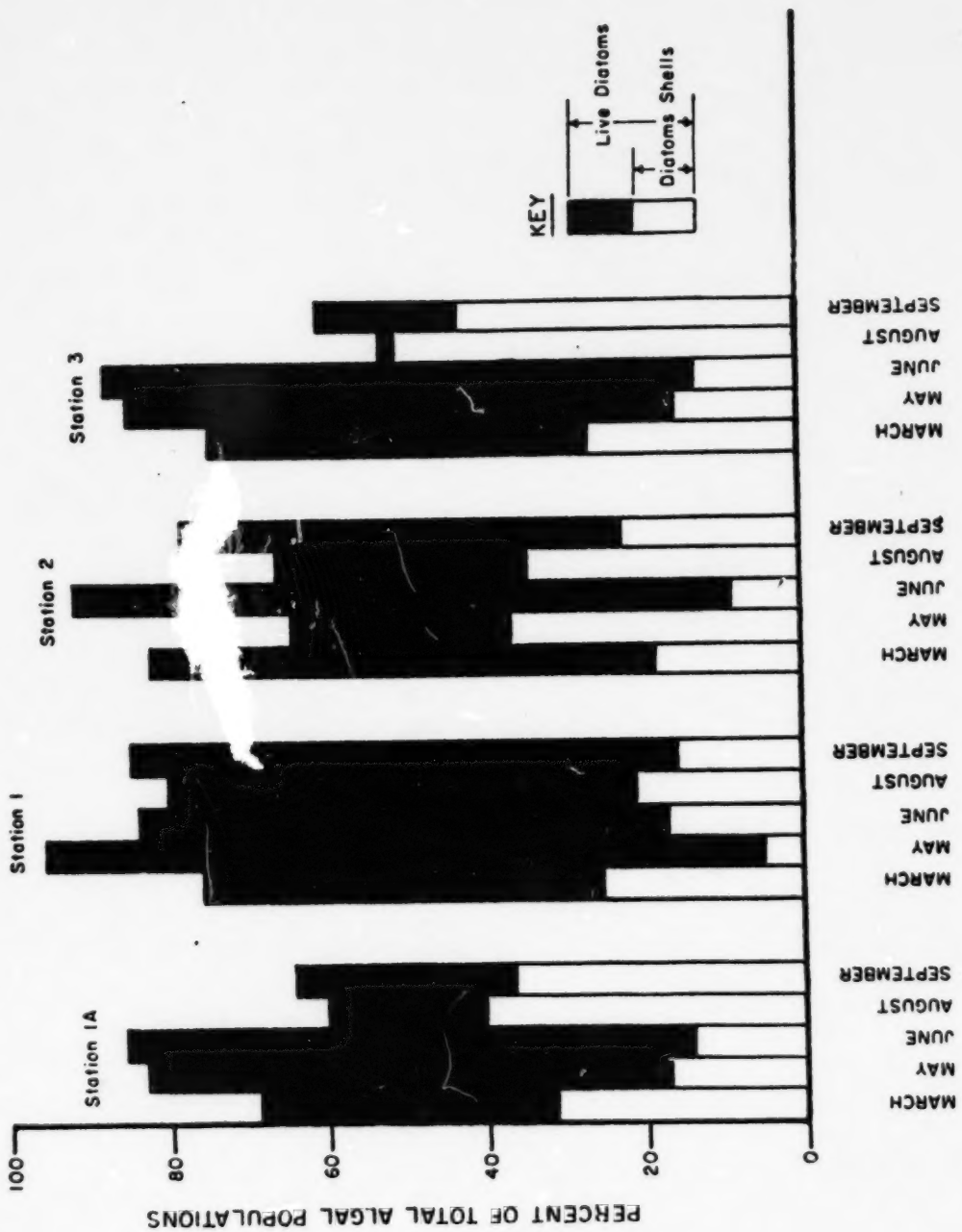
It is possible that the pennate diatom populations were able to maintain their high numbers at the downstream stations during September as a result of the diesel fuel supressing other algal forms. Keuss, et al.(11) related the growth inhibition of Dinobryon sertularia and Peridinium sp. to the presence of a crude oil slick.

The portion of dead pennate diatom cells at the control station (Station 1A) decreased from 31 percent in March to 17 percent in May and 14 percent in June. The number of dead pennate diatom cells increased to near March levels during August and September (Figure 8). Weber and Raschke (12) found that the proportion of dead cells in a series of periphyton samples from the Ohio River ranged from 2 to 23 percent in October.

A somewhat more active pennate diatom growth was noted at the first downstream station (Station 1). Dead pennate diatoms decreased to a low of 5 percent in May and did not increase to the high levels seen at the control station during August and September. The number of dead pennate diatom shells at the middle downstream station (Station 2) increased during

FIGURE 8

MONTHLY COMMUNITY PERCENTAGE COMPOSITION OF LIVE AND DEAD PENNATE DIATOMS, BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER, 1972



May but later decreased to reach the season low of 9 percent in June. The periphytic community at the lower station (Station 3) resembled the community described from the control station both in percent of dead pennate diatoms and the seasonal cycle.

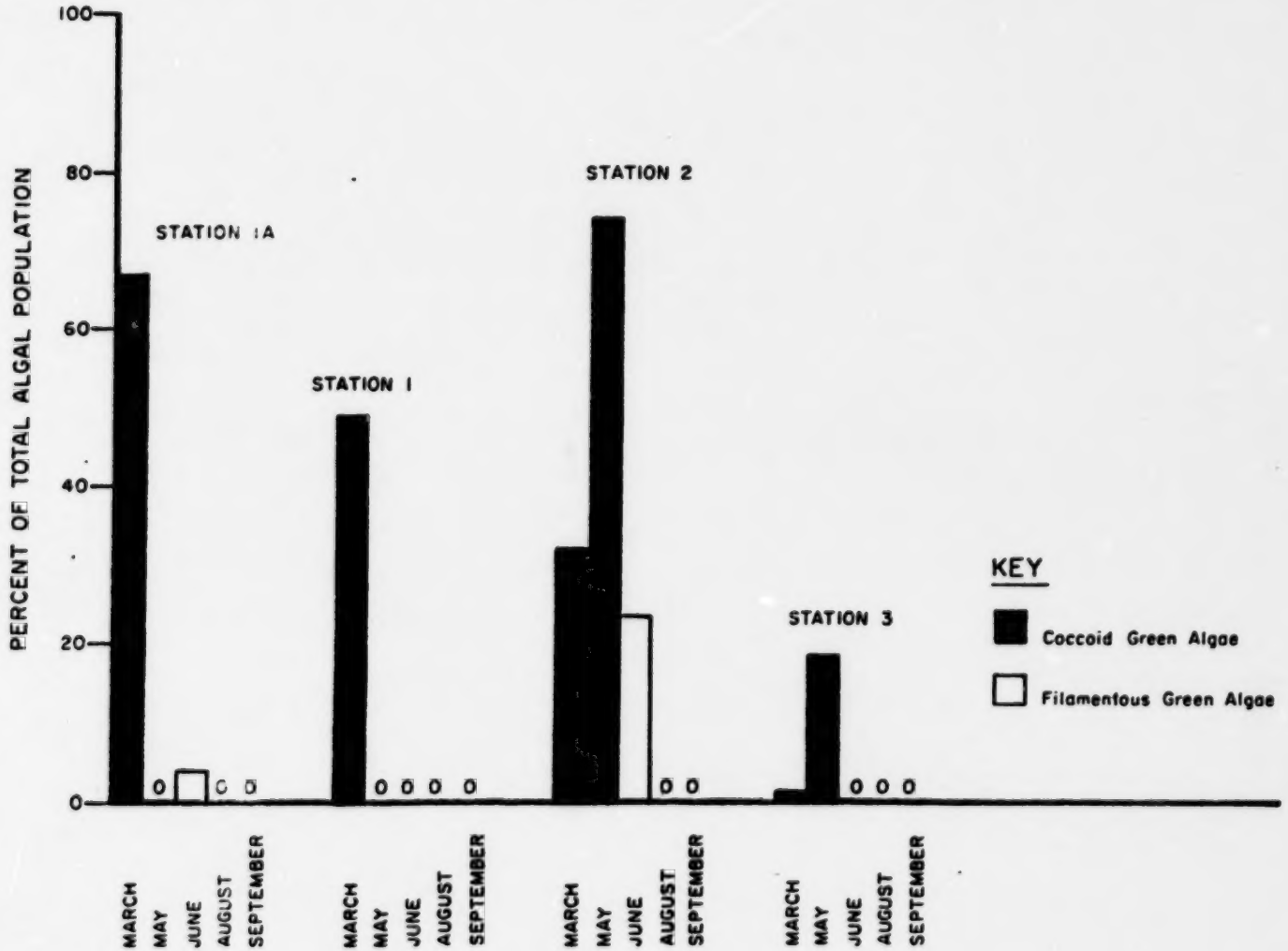
Filamentous blue-green algae increased in community percentage from March to June at the control station (Station 1A), was absent during August, and increased to the highest community percentage at the control station during September (Figure 5). The filamentous blue-green algae at downstream stations did not appear to follow this cycle. The first and lower stations (Stations 1 and 3 respectively) had a large population in June, which decreased to very low numbers in September (Figure 6). The filamentous blue-green algae at the middle downstream station (Station 2) decreased in community percentage all season. Filamentous blue-green algae dominated the periphyton communities at Stations 1 and 3 during June. Oscillatoria was the dominant genus of filamentous blue-green algae. Anabena was collected at the first downstream station during March. McCauley found Oscillatoria tolerating diesel fuel for an extended period in the Muddy River, Massachusetts (8). Ahearn (7) noted an increase in filamentous blue-green algae downstream from a discharge of waste oil. Kauss, et al., found high populations of Anabena flosaquae in a growth culture that had been exposed to crude oil (11).

Filamentous green algae of the genra Spirogyra were present in low numbers at the control station (Station 1A) during June (Figure 5). None was present at the first downstream station. Stigeoclonium was present at the middle downstream station (Station 2) during June.

Kauss, et al (11) observed that crude oil stimulated the growth of several different algae. They suggest that this indicates that some algae

FIGURE 9

MONTHLY COMMUNITY PERCENTAGE OF COCCOID AND FILAMENTOUS GREEN ALGAE, BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER, 1972



are either able to assimilate water soluble hydrocarbons directly or the by-products produced by fungal degradation of the oil. A number of other factors may have contributed to the observed population increases.

Fungi

During the August survey, samples of clay and sediment were collected along the banks of Boone Creek. These samples were cultured for fungal growths capable of utilizing diesel fuel as a growth medium. Filamentous fungi of the genus Fusarium were isolated in high numbers from the station immediately downstream from the oil spill (Station 1). Fusarium grew well with diesel fuel as the only source of carbon. This genus was not cultured from sediment samples taken at the station upstream from the spill (Station 1A). Lesser numbers of Fusarium were found in samples collected from the second station downstream from the oil spill (Station 2). Fusarium populations in a small stream below an asphalt plant were found to increase in number following a discharge of waste oil into the system (7). Yeast populations in the same stream increased from a range of 30 to 200 cells per milliliter to 10,000 to 100,000 cells per milliliter during the week following the spill (7). The yeast population gradually decreased and within a month had returned to the normal level (7).

Sediment

Oil from the overturned truck flowed down a side hill for a distance of about 100 feet before entering Boone Creek. Much of the oil seeped into the sandy soil. This accumulated oil was seen seeping into Boone Creek during the entire survey.

The diesel fuel mixed with the water column of Boone Creek and became assimilated into the stream bed and clay banks. Clay minerals with absorbed

organic matter are an excellent absorbent of hydrocarbons (6). Personal experience has shown that sand by itself is a poor absorbent of diesel oil. Diesel fuel was found incorporated into the substrates of Buzzard Bay 8 months after the spill occurred (6).

Any disturbance of the stream substrate during the survey period released oil into the stream. A strong smell of diesel oil and an oil sheen on the water also occurred whenever stones were overturned.

Chemical Analysis for Hydrocarbons

Sediment samples taken from the first and third downstream stations (Station 1 and 3) during March, June, August, and September 1972 and March 1973 all contained diesel fuel. Chromatograms of the oil samples showed progressive reduction of low boiling point hydrocarbons and loss of lower boiling sulfer compounds during the 13-month period. Blumer, et al. (10) also noted the decrease of lower molecular weight hydrocarbons from a sample of oil recovered from a sediment sample.

Oil contained in sediment samples obtained from the second downstream station (Station 2) during August and September 1972 also was degraded.

Sediment samples collected at Station 4 on Lake Keowee during May and June 1972 did not contain hydrocarbon. Oil was detected in the samples collected from Station 4 during August and September 1972 and March 1973.

It is probable that the oil was not spread over as wide an area during early 1972 and had since spread out as it was during the later sampling period. Blumer (10) found redistribution of diesel fuel on the bottom of Buzzards Bay off West Falmouth, Massachusetts. It is also probable that oil leached out of the creek substrate after June 1972 had increased the coverage over the lake bottom.

Water samples were only collected during the March 1972 sampling period. These samples were taken at the Lake Keowee station (Station 4). Samples were collected near the surface and the lake bottom. No oil was detected in these samples.

Periphyton collected during June and August at the first downstream station contained recognizable diesel fuel.

Insects and crayfish collected at Stations 1 and 3 during March 1972 contained diesel fuel. Benthic samples for hydrocarbon analysis were not collected during any other period.

Fish collected during March 1972 at the most downstream station (Station 3) on Boone Creek contained diesel fuel.

Table 1

ARTIFICIAL SUBSTRATE BENTHIC DATA FROM THREE STATIONS ON BOONE CREEK NEAR SALEM, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Number of Organisms											
	Station 1A				Station 1				Station 3			
	May	Jun	Aug	Sep	May	Jun	Aug	Sep	May	Jun	Aug	Sep
Chironomidae												
Cricotopus bicinctus									2			
Ablabesmyia auriensis					1							
Arctopelopia sp.	1				1							
Tanytarsus sp. E Joh.	1											
T. exiguus				4						1		
Nanocladius sp. 2 Roback										1		
N. alternantherae										1	2	
N. sordens								1				
Tendipedini sp. C. Roback										3		
Diamesa longimanus						1						
Polypedilum scalaenum						1						
P. fallax								1				
P. halterale								1				
P. tritum				2								
Endochironomus sp.								1				
Paratendipes sp.								1				
Conchapelopia sp.				1							5	
Thienemanniella xena				1								
Brillia sera											1	
B. sp.				1								
Trichocladius sp. 1 Roback				1								
T. robacki				1								
Metriocnemus sp.				2								
Larsia sp.								3			2	
Glyptotendipes lobiferus				1								
Stenochironomus sp.											1	
Tipulidae												
Pedicia sp.										1		
Ceratopogonidae												
Probezzia sp.					1				1			
Simulidae												
Simulium sp.										1		
Dolichopodidae												
Unidentified sp.											1	
Hydropsychidae												
Hydropsyche sp.		1	1				3					
Cheumatopsyche sp.	1	14	100	5								
Diplectrona modesta		6	1	6								
Rhyacophilidae												
Rhyacophila sp.				1								
Limnephilidae												
Neophylax sp.				1								

Table 1
(Continued)

Taxa	Number of Organisms											
	Station 1A				Station 1				Station 3			
	May	Jun	Aug	Sep	May	Jun	Aug	Sep	May	Jun	Aug	Sep
Heptageniidae												
Stenonema sp.	3	7	19	39	6	1	3					1
Arthroplea sp.			1									
Ephemerellidae												
Ephemerella dorothea	4	1			1							
E. minimella				1								
Baetidae												
Baetis sp.		2			2							
Centroptilum sp.			3	2								1
Leptophlebiidae												
Paraleptophlebia sp.	1					1						
Gomphidae												
Ophiogomphus carolus						2				1		
Aeschnidae												
Boyeria vinosa		1								1		
Chloroperlidae												
Hastaperla brevis	1											
Nemouridae												
Leuctra sp.		5	9									
Peltoperlidae												
Peltoperla sp.		7	23	1								
Perlidae												
Acroneuria arida	20	11	15	2	2							
A. abnormis	16	20	5	3	3							
Perlodidae												
Isogenus sp.		4										
Psephenidae												
Psephenus sp.	1			1								
Elmidae												
Stenelmis sp.		2		1			1					
Optioservus sp.		1										
Dytiscidae												
Rhantus sp.			1									
Ptilodactylidae												
Unidentified sp.				1								
Corydalidae												
Nigronia fasicatus		1	1									
N. serricornis		5	1									
Chauliodes sp.			1									
Astacidae												
Cambarus sp.			1					2				
Total taxa	10	16	15	22	8	5	3	7	2	8	6	2
Total organisms	49	88	182	78	17	6	7	10	3	10	12	2

Table 2

QUALITATIVE BENTHIC DATA FROM STATIONS ON BOONE CREEK NEAR SALEM, SOUTH CAROLINA

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Tubificidae																				
Limnodrilus udekemianus	1											1				1				
Branchiobdellidae			15																	
Chironomidae																				
Procladius adumbratus						1														
Arctopelopia sp.	2	1																		
Brillia sp.		2																		
Trichocladius sp. 1 Roback		1				1								1						
Phaenopsectra obediens						1														
Tanytarsus exiguus	2	1																		
T. guerlus	1																			
T. sp. A Beck	1																			
Polypedilum fallax																	1			
P. illinoense						1														
P. parascalaenum						2														
P. scalaenum			1															1		
Stenochironomus hilaris														1						
Cryptochironomus fulvus						3														
Larsia lurida						3								2						
Psectrotanypus dena	1					1														
Orthocladinae						1														
Orthocladius dubitatus						1														
O. thienemanni						1														
Nanocladius sp. 1 Roback						2														
N. sordens	1																			
N. alternantherae	2													2						
Cricotopus sp. 2 Roback						4														
C. junus						1														
C. fugax						2														
C. slossonae																		9		
C. bicinctus																		2		

Table 2
(Continued)

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Nemouridae																				
Leuctra sp.		1			3													4		
Pteronarcidae																				
Pteronarcys proteus	6										3					13				
Perlodidae																				
Isogenus sp.			1					2												
Isoperla clymene			2			6														
Chloroperlidae																				
Hastaperla brevis		1				1	1													
Perlidae																				
Acroneuria arida	1	1			6		3		2	1						2				
A. abnormis		1			4	1	1									5		3		
Baetidae																				
Baetis sp.			2			1														3
Centroptilum sp.					1													1		
Isonychia sp.			2					1												
Leptophlebiidae																				
Paraleptophlebia sp.		1																		
Leptophlebia sp.				4																
Ephemeridae																				
Hexagenia limbata	2				1	1	1				1					9				
Ephemera varia						1														
Heptageniidae																				
Stenonema sp.	8	2	2	8	17	3			2	5					3			1		
Epeorus sp.																		2		1
Ephemerellidae																				
Ephemerella dorothea	6		1			4	1		1		3									
E. funeralis	2																			
E. minimella																				1
Agrionidae																				
Calopteryx sp.	4	4		2				1											3	4

Table 2
(Continued)

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Chironomidae																				
Metriocnemus sp.						4														
Harnishia nais						1														
Pentaneura sp.																				
Microtendipes pedellus						2												1		
Diamesa fulva						1														
D. longimanus			1																	
Cardiocladius obscurus																		1		
Parachironomus sp.						7												12		
Conchapelopia sp.			1					3						5						
Tipulidae																				
Tipula sp.				1		1		1			1	1		1		17	1			
Limonia sp.		3	1										1							
Dicronota sp.						1														
Eriocera sp.						1														
Ceratopogonidae																				
Probezzia sp.						2														
Forcipomyia sp.													1							
Dasyhelea sp.						2														
Palpomyia sp.	1					6														
Tabanidae																				
Tabanus sp.						1						2	1							
Chrysops sp.		1				1														
Simuliidae																				
Simulium sp.								1			1									
Psychodidae																				
Psychoda sp.						1					1									
Dixidae																				
Dixa sp.								1	1											
Peltoperlidae																				
Peltoperla sp.	1	6	28	1	5				1	1						1				

Table 2
(Continued)

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Coenagrionidae																				
Argia sp.						1														
Aeschnidae																				
Boyeria vinosa	2		3	7	5			2		4										
Gomphidae																				
Ophiogomphus carolus		8	4	1		1	5	1				2	2			2				
O. mainensis					7					5									1	1
Lanthus parvulus							1													
L. albistylus	1																			
Dromogomphus armatus	4	1	2									1				1				
D. spinosus		3															3			
Libellulidae																				
Macromia magnifica							1		1	1	1		2							1
Cordulegastéridae																				
Cordulegaster sayi	2		1		1	1					1					2		2		1
Hydropsychidae																				
Hydropsyche sp.		2	1		1															
Cheumatopsyche sp.		2	1		1	1					2					1				
Diplectrona modesta		1		2																
Psychomyiidae																				
Nyctiophylax		2														1				
Lype diversa					2															
Rhyacophilidae																				
Rhyacophila fuscula		2				1	1	1			1					1				
Glossosoma sp.																				
Limnephilidae																				
Neophylax nactus		19			1															
Pycnopsyche luculenta			2			3	1						1							
Sericostomatidae																				
Sericostoma sp.																1				

Table 2
(Continued)

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Odontoceridae																				
Psilotreta sp.			1																	
Anisocentropus pyraloides					1	4														
Lepidostomatidae																				
Lepidostoma sp.			1			2														
Gerridae																				
Gerris sp.						1														
Veliidae																				
Rhagovelia sp.			4	1	6															
Corydalidae																				
Nigronia fasicatus	2		1																	
N. serricornia	2					1														
Corydalus sp.																			1	
Gyrinidae																				
Dineutus sp.		1		2	1															
Ptilodactylidae						2								1						
Psephenidae																				
Psephenus sp.					1						3									
Elmidae																				
Stenelmis sp.						3									1			1		
Promorsia tardellus			1																	
Optiservus immunis			1																	
Microcylloepus pusillus																				1
Dryopidae																				
Helichus sp.			1	2																
Astacidae																				
Cambarus sp.	2	1	9	7	9	3	1		2	6	7	1		1	1				1	3
Gastropoda																				
Pleurocera sp.																				3
Gyralus sp.																		1		1
Bivalvia																				
Sphaerium sp.																				1

Table 2
(Continued)

Taxa	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept	Mar	May	June	Aug	Sept
Total Taxa	24	25	27	12	19	50	11	10	7	7	12	6	6	8	3	14	3	14	4	12
Total Organisms	57	68	90	38	73	98	17	14	10	23	25	8	8	14	5	57	5	41	6	21

Table 3

INVERTEBRATE BENTHIC ORGANISMS COLLECTED BY SURBER SAMPLER AT STATIONS ON BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Number of Organisms											
	Station 1A			Station 1			Station 2			Station 3		
	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep
Chironomidae												
Psectrocladius sp. 2									1			
Cryptochironomus fulvus												1
Nanocladius alternantherae						1						
N. sordens												1
N. sp. 2 Roback						1						
Conchapelopia sp.		1				6			11			6
Polypedilum illinoense	2											
P. halterale	1		1									
P. fallax										1		
P. tritum			1									
Micropsectra dives			1									
Tanytarsus exiquus			1									
Thienemanniella xena			1			3						
Trichlocladius robacki						2						
Glyptotendipes lobiferus			2			1						
Cardiocladius sp.						3				2		
Cricotopus slossonae				3		3				11		1
C. bicinctus						16			11	1		3
Metriocnemus sp.	2		6									
Muscidae												
Unidentified sp.										1		
Tipulidae												
Pedicia sp.	8			2								
Hexatoma sp.	1											
Dolichopodidae												
Unidentified sp.									1			
Ceratopogonidae												
Probezzia sp.	1											
Palpomyia sp.	1											
Empididae												
Hemerodromia sp.									5			
Dixidae												
Dixa sp.									1			
Tabanidae												
Tabanus sp.			1									
Nemouridae												
Leuctra sp.			1									
Perlidae												
Acroneuria abnormis			1									
A. arida			1									
Heptageniidae												
Stenonema sp.		1	5	2		5			5		3	

Table 3
(Continued)

Taxa	Number of Organisms											
	Station 1A			Station 1			Station 2			Station 3		
	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep	Jun	Aug	Sep
Baetidae												
Baetis sp.			5						1		1	
Centroptilum sp.			1			10			8			
Hydropsychidae												
Cheumatopsyche sp.	1	1	2	3		1					2	
Rhyacophilidae												
Glossosoma sp.		1										
Gomphidae												
Ophiogomphus carolus				1								
Ophiogomphus mainensis			1			2			2			
Aeschnidae												
Boyeria vinosa									1			
Corydalidae												
Corydalus sp.						1					1	
Elmidae												
Stenelmis sp.	1					1			1	1		
Optiservus sp.				1								
Psephenidae												
Psephenus sp.		1	1									
Astacidae												
Cambarus sp.									1			
Total Taxa	9	5	17	6	0	15	0	0	13	6	4	5
Total Individuals	18	5	32	12	0	56	0	0	49	17	7	12

Table 4

TOTAL NUMBER OF TAXA (SPECIES OR GENUS) IN THE MAJOR GROUPS OF INVERTEBRATE BENTHIC ORGANISMS COLLECTED FROM STATIONS ON BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Group	Number of Organisms																			
	Station 1A					Station 1					Station 2					Station 3				
	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept
Worms	1		1									1				1				
True flies	8	8	11	2	12	28	1	8	1	15	3	2	3	6	6	1	4	12	6	5
Caddisflies		6	6		7	5	2	2	1	1	2	-	1	-	-	4	-	-	-	-
Mayflies	4	3	4	4	5	5	4	3	2	2	2	-	-	-	3	1	-	3	-	5
Stoneflies	3	5	6	4	4	3	3	1	2	2	1	-	-	-	-	4	-	2	-	-
Dragonflies	5	4	4	-	3	3	3	-	1	3	2	2	2	-	2	3	1	3	2	4
Alderflies	2	-	2	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1	-
Beetles	-	2	4	-	4	2	-	1	1	1	1	-	-	1	1	-	-	1	1	1
Crayfish	1	1	1	-	1	1	1	-	-	1	1	1	-	1	1	-	-	-	1	1
Snails	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2
Clams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Waterbeetle	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	24	29	40	11	37	49	14	15	8	26	12	6	6	8	13	14	5	22	10	29

Table 5

INVERTEBRATE BENTHIC ORGANISMS COLLECTED BY PONAR DREDGE FROM STATION 4 ON LAKE KEOWEE, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Number of Organisms														
	March			May			June			August			September		
	Haul			Haul			Haul			Haul			Haul		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Chironomidae															
Procladius adumbratus	1	2	1				2								
Procladius culiciformis		3													
Dicrotendipes modestus		1													
Tanytarsus guerlus		2													
Psectrocladius sp.								1							
Ceratopogonidae															
Palpomyia sp.		2													
Culicidae															
Chaoborus punctipennis	1	3	1	4	1	3		2	3		8		9	16	11
Total taxa	2	6	2	1	1	1	1	2	1	0	1	0	1	1	1
Total organisms	2	13	2	4	1	3	2	3	3	0	8	0	9	16	11

Table 6

FISH COLLECTED FROM BOONE CREEK

Fish	Station 1A			Station 1			Station 3		
	Dead	Shocked		Dead	Shocked		Dead	Shocked	
	March	March	Sept.	March	March	Sept.	March	March	Sept.
Bluehead chub		62	68	2	5	26	8	5	25
Redhorse sucker		10	8	1	1	3	3	1	2
Creek chub		36	50		4	62		4	15
Yellowfin shiner		95	116			26	1		21
Hog sucker							1		1

Table 7

AVERAGE NUMBER OF PERIPHYTIC ALGAL CELLS PER MILLILITER
BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Station 1A					Station 1					Station 2					Station 3				
	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept
Blue-green																				
Filamentous	224	14	11		22	225	16	93	8	12	516	14	19	8	18	1216	23	87	4	8
Green																				
Coccoid	1496		1			1259					501	143				19	23			
Filamentous			1										45							
Flagellates																				
Green											9						1			
Other																6				
Diatoms																				
Centric			3		8					8					2					8
Pennate	542	73	36	3	49	945	91	30	53	594	544	36	136	51	308	4881	78	46	50	150
Total Algae																				
Live	2262	87	52	3	79	2403	107	123	61	614	1565	193	200	59	328	6116	125	133	54	164
Inert Diatom Shells																				
Centric			1							4					2					2
Pennate	243	15	6	2	28	318	5	6	14	105	117	20	13	26	85	1683	14	7	47	65

Table 8

MONTHLY PERIPHYTIC ALGAL PERCENTAGE COMPOSITION AT STATIONS ON BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Station 1A					Station 1					Station 2					Station 3				
	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept
Blue-green																				
Filamentous	.10	.16	.21	---	.28	.09	.15	.76	.13	.02	.33	.07	.09	.14	.05	.20	.18	.65	.07	.05
Green																				
Coccoid	.66		.02			.52					.32	.74				.003	.18			
Filamentous			.02										.23							
Flagellates																				
Green											.001									
Other																.001	.01			
Diatoms																				
Centric			.06		.10					.01					.01					.05
Pennate	.24	.84	.69	100	.62	.39	.85	.24	.87	.97	.35	.19	.68	.86	.94	.80	.63	.35	.93	.90

Table 9

PERCENT COMPOSITION OF LIVE/DEAD PERIPHYTIC DIATOMS
FROM BOONE CREEK, SOUTH CAROLINA, MARCH-SEPTEMBER 1972

Taxa	Station 1A					Station 1					Station 2					Station 3				
	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept	Mar.	May	June	Aug.	Sept
Pennate Diatoms																				
Live	.69	.83	.86	.60	.64	.75	.95	.83	.79	.85	.82	.64	.91	.66	.78	.74	.85	.87	.52	.60
Shells	.31	.17	.14	.40	.36	.25	.05	.17	.21	.15	.18	.36	.09	.34	.22	.26	.15	.13	.48	.40
Centric Diatoms																				
Live			.75		100					.67					.50					.80
Shells			.25		0					.33					.50					.20

REFERENCES

1. Smith, Al J. 1972. Applied control techniques - Successes and failures with oil spills in the southeastern inland waters. Conference on Prevention and Control of Oil Spills, Edison, N.J., March 1973.

2. Blumer, Max. 1971. Scientific aspects of the oil spill program. Environmental Affairs 1(1).

3. Prescott, G. W.. 1962. Algae of the western Great Lakes. Wm. C. Brown Co., Inc., Dubuque, Ia. 977 pp.

4. Mason, William. 1967. A limestone-filled, artificial substrate sampler-float unit for collecting macroinvertebrates in large streams. Prog. Fish-Cult. 29: 74.

5. Bugbee, S. L. and C. M. Walter. 1972. The effects of gasoline on the biota of a mountain stream. Unpubl. Rep.

6. Blumer, Max. 1971. Scientific aspects of the oil spill problem. Environmental Affairs 1: 54-73.

7. Turner, W. and D. Ahearn. 1970. Ecology and physiology of yeasts of an asphalt refinery and its watershed. Spectrum 9: 113-123.

8. McCauley, R. 1966. The biological effects of oil pollution in a river. Limnol. & Oceanogr. 11: 475-486.

9. Falanruw, M. 1973. West Fayu oil spill. YAP Institute of Natural Science, Report 1.

10. Blumer, M. and J. Sass. 1972. Oil pollution: Persistence and degredation of spilled fuel oil. Sei. 176(4039): 1120-1122.

11. Keuss, P., T. C. Hutchinson, C. Soto, J. Hellebust, and M. Griffins. 1972. The toxicity of crude oil and its components to fresh-water algae. Proc. Conf. Prevention and Control of Oil Spills, 1973.

12. Weber, C. and R. Raschke. 1966. Use of a floating periphyton sampler for water pollution surveillance. Water Pollution Surveillance System Applications and Development Report No. 20.